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PHYSICS.—*A note on electrical conduction in metals at low temperatures.* F. B. SILSBEE, Bureau of Standards. (Communicated by P. G. Agnew.)

Some time ago I had occasion to study the accounts of the brilliant experiments of Kamerlingh Onnes on the resistivity of various metals at liquid helium temperatures. In so doing I have noticed a certain correlation between the phenomena of critical current density and critical magnetic field. Though the relationship seems quite obvious I have come across no mention of it in the literature of the subject, and think it worthy of notice as furnishing a possible clue to further theories of metallic conduction.

The present state of our experimental knowledge of the subject is somewhat as follows. Certain metals—mercury, tin, and lead—at the very low temperatures obtainable in a bath of liquid helium show a very greatly increased electrical conductivity, to which Kamerlingh Onnes has given the name "superconductivity." The actual resistivity of the metal in this state is too small to measure but has been shown[1] to be less than 2×10^{-11} times the resistivity at 0°C. As the temperature of any of these metals is lowered from room temperature, the resistance decreases uniformly with the normal coefficient of about 0.4 per cent per degree until the temperature has become very low, then the rate of decrease becomes for a time less rapid. At a certain critical temperature (4°.2 K for mercury, 3°.8 K for

[1] Kon. Akad. v. Weten. Amsterdam, 17: 280.

tin, and 6° K for lead),[2] however, there is a sudden break in the curve connecting resistance and temperature, and within a temperature range of a few hundredths of a degree the resistance drops from about 10^{-3} times its value at 0°C. to less than 10^{-10} times the same value. Other metals, such as gold, silver, platinum, and iron, do not show this phenomenon but tend to approach a constant value as the temperature is lowered to the lowest value (1°.6 K) at which such measurements have been made. The critical temperature at which the change occurs is very definite when the current used to measure the resistance is small, but when the measuring current is very large the critical temperature is found to be definitely lower. Conversely, if the temperature of the bath be held constant some degrees below the critical value and the current be increased, a certain "threshold" value of current will be found at which the resistance suddenly appears.[3] The lower the temperature the greater the value of the critical current.

It is further found that when a superconductor is placed in a weak magnetic field it remains superconducting; but that, as the field is increased, the normal resistance appears suddenly at a certain critical value of the magnetic field, and for still higher values of the field it increases slowly with the field.[4] The critical value is slightly less when the field is transverse to the direction of current flow than when it is longitudinal, but the difference is not great.

The particular point which is the subject of this note is that *the "threshold" value of the current is that at which the magnetic field due to the current itself is equal to the critical magnetic field.* In other words the phenomenon of threshold current need not be regarded as a distinct phenomenon, to be explained by heating, or otherwise, but is a direct result of the existence of the phenomenon of threshold magnetic field.

If the specimen is in the form of a coil of wire it is evident that the inner turns are in a magnetic field, due to the current in the

[2] Comm. Phys. Lab. Leiden, No. 133, pp. 7, 52, 60.
[3] *l.c.*, p. 3.
[4] Comm. Phys. Lab. Leiden, No. 139, pp. 65–71.

other turns, which is very similar to that due to an entirely external electromagnet. Consequently, when this field reaches the critical value, first the inner turns will become resisting and, as the current is increased, more and more of the wire will cease to be superconducting. Because of the enormous factor by which the conductivity decreases from the superconducting to the normal state, most of this decrease will take place when only a small fraction of a turn of the coil ceases to be superconducting. Owing to the cumulative effect of the successive turns, the field produced by a given current is much greater in the coil than in the same wire when straight, and, consequently, the current required to give the critical field strength will be much less. This is verified by the results of Onnes[5] on coils of lead and tin wire for which the critical currents were, respectively, $\frac{1}{15}$ and $\frac{1}{8}$ of those for the same wire when straight. No attempt has yet been made to measure the further gradual increase of resistance, which would be expected on this theory, as the current is further increased and more and more turns become resisting.

In the case of a straight wire of circular section the effect to be expected is rather more complicated. Consider a superconducting wire of radius r_0 carrying a current I, uniformly distributed over the cross-section. The magnetic field intensity H at any point, distant r from the axis, but *inside* the wire, is given by

$$H = \frac{2Ir}{r_0^2} \tag{1}$$

and that at the surface of the wire by

$$H_0 = \frac{2I}{r_0} \tag{2}$$

If the current be increased to a value slightly greater than $\frac{H_c r_0}{2}$, where H_c is the critical field intensity for the material, the outermost layer of the wire will become resisting. Since this

[5] Comm. Phys. Lab. Leiden, No. 133, pp. 57, 60.

layer is shunted by the superconducting core, the whole current will tend to flow in this core. This, however, would make the field at the edge of the core even greater than that in the former outer layer, since by equation (2) the field varies inversely as the external radius.

The system is therefore unstable and the current will shift suddenly to a new distribution. This distribution will depend on the exact form of the relation connecting resistivity with magnetic field; and if this relation were known, the current distribution might be computed from the usual electromagnetic equations.

If it be assumed that the resistivity increases discontinuously by a large factor, k, at a definite field intensity H_c, then for a current very slightly in excess of the critical value there will be a superconducting core of radius $\frac{r_0}{k}$, in which the current density will be k times the average value; and therefore $\frac{1}{k}$ of the total current will flow in this core. Outside of the core the material will be in a field equal to or greater than H_c and will by hypothesis have an increased and uniform resistivity. Since the core is so small that in spite of the great current density existing there it carries only a small part of the total current, the resistance of the wire as a whole is nearly k times the superconducting value. For the materials studied k is of the order of 10^7, so that the effect of the core is negligible.

For any other relation between resistivity and field there would be a corresponding current distribution. In general the abruptness of the increase of resistance with current would be similar to that of the increase of resistivity with field.

Owing to the great experimental difficulties of working at these extreme temperatures the data available for an experimental verification of this theory are rather scanty. Table 1 contains in condensed form the observed values of threshold current for various wires at different temperatures, as published by the Leiden laboratory. Since the threshold values depend considerably on temperature, a comparison is possible only when ob-

servations have been made on two wires at the same temperature; the table contains the results of practically all such observations that have been published.[6]

TABLE 1

CRITICAL VALUES OF CURRENT FOR VARIOUS METALS AND TEMPERATURES
Data by H. K. Onnes

TEMP.	AREA	THRESHOLD CURRENT	THRESHOLD CURRENT DENSITY	MAX. MAG. FIELD
		Mercury		
deg, K	*mm.²*	*amperes*	*amperes/mm.²*	*gauss*
4.1	0.0016	0.17	107	15
	0.0025	0.17	69	12
	0.0055	0.23	42	11
	0.0055	0.32	58	15
3.6	0.0016	1.00	625	89
	0.0025	1.07	427	76
	0.0040	>1.04	>260	>59
	0.0052	0.78	151	39
		Tin. $H_{crit.}$ = 200 at 2°K		
1.6	0.0143	1.0	70	430 coil
	0.0143	8.0	560	240 st. wire
		Lead. $H_{crit.}$ = 600 at 4°.2 K		
4.25	0.025	9.0	680	385 st. wire
	0.014	>4.0	>300	>110 in vacuo
	0.014	0.6	41	375 coil
1.7	0.014	0.84	60	550 coil
	0.014	11.10	790	330 st. wire

In the last column is given the maximum value, within the conductor, of the magnetic field due to its own threshold current, that is, the field at the surface of a straight wire or at the inner turns of a coil (the computations for the latter case being only

[6] Comm. Phys. Lab. Leiden, No. 133.

approximate). It is seen from the table that at each temperature this magnetic field is much more nearly a constant of the material than either the current or the current density. In the case of mercury the effect of a magnetic field on the resistance in the superconducting state has not been measured. For tin the threshold value at 2°K is about 200 gauss, which is in good agreement with the slightly larger values computed from the threshold current corresponding to a slightly lower temperature. In the case of lead the agreement of the observed critical field (600 gauss at 4°K) with the computed values is not so good, particularly in the case of the straight wire. Any discrepancy here, however, is easily explained by the possibility (frequently referred to by Onnes) of the existence in the wire of thin spots where the field intensity would be much greater for a short length.

Further experiments immediately suggest themselves. The critical magnetic fields for mercury should be determined. The relation here advanced would indicate a critical field of only about 15 gauss at 4°1K and less than 100 gauss at 3°6K. It would also be of interest to observe the threshold value of current when the material is in very thin films. In this case, for a given section of material the magnetic field resulting from a given current density is less than in the case of a straight wire, and the threshold current density would consequently appear larger.

The theories thus far proposed by Onnes,[7] Lindemann,[8] and Thomson[9] to account for superconductivity do not specifically indicate the existence of a critical magnetic field, and only the latter (by assuming a saturation effect) accounts for a threshold current density. If it is true, as indicated in this paper, that the magnetic effect is the more fundamental, it would seem that this fact might afford a valuable clue leading toward a more satisfactory theory of the superconducting state and perhaps of metallic conduction in general.

[7] ONNES. Comm. Phys. Lab. Leiden, No. 119.
[8] LINDEMANN, F. C. Phil. Mag., **29**: 127. 1915.
[9] THOMSON, J. J. Phil. Mag., **30**: 192. 1915.

BIOLOGY.—*Geochemical evidence as to early forms of life.*[1] F. W. CLARKE, Geological Survey.

When life began on earth the conditions favorable to its development were, generally speaking, somewhat different from what they are today. Rocks derived from the remains of living organisms did not, of course, exist; and the only sediments were those due to erosion, increased, doubtless, by volcanic dust and other ejectamenta. The surface of the land was made up of primitive rocks, and among them the specifically lighter varieties probably predominated. By erosion these rocks were gradually decomposed, and their more soluble constituents were taken up by the primeval waters, whose character gradually changed as the process of erosion went on. At first, silica and alkalies passed into solution, with lime and magnesia in much smaller proportions. A large part of the lime and magnesia in the waters of today is derived from the solution of limestones of organic origin, which came into existence later. Possibly algal and foraminiferal limestones were among the earliest to form large masses, but of that it is not well to be too positive. We can only assume that the simplest forms of life came first, even though their remains have since been obliterated. In geologic time the complex forms are relatively modern.

So far as we are able to judge from anything like positive evidence, the earliest living organisms were aquatic, and their physical constitution was determined by the character of their environment. Whether the waters were warm or cold we do not know, and speculation upon that subject is hardly profitable. Whether the primeval ocean was fresh or saline is also uncertain, but we can assert that the composition and concentration of its dissolved salts have undergone great changes and are still changing. The enormous load of saline matter annually poured into the ocean by rivers is evidence that can not be ignored. Part of that load remains in solution, part is precipitated, either directly or through the agency of plants and animals, and so the changes are brought about. These changes in the environment

[1] Published with the permission of the Director of the U. S. Geological Survey.

of life must have affected the course of evolution, although with exceeding slowness. Every variation in the composition of the fluviatile or oceanic salts modified the conditions under which life developed. As living organisms multiplied, they in turn altered the composition of the waters, by just so much as they withdrew lime, or magnesia, or phosphoric oxide, or silica from solutions and used them in building up the sedimentary cherts, phosphorites, and limestones of today.

To trace these changes in detail would be difficult, if not impossible, but some of the ancient conditions can reasonably be inferred. The chemical reactions involved in the discussion are the same now as at the beginning, although the results produced by them have varied from time to time and place to place. The chemical elements are not uniformly distributed; at one point there is more silica, at another more lime; and organisms with siliceous, calcareous, or phosphatic shells or skeletons developed in accordance with their surroundings. Where the primeval waters were relatively rich in silica, siliceous organisms were most readily evolved; where lime predominated, the development of calcareous organisms was favored. So much seems to be clear.

It has already been stated that the land surface of the earth was at first composed of rocks such as form only one fourth of it today; that is, of igneous, plutonic, or crystalline rocks with no sedimentaries of organic origin. At present persilicic rocks of granitic or granitoid type are the most abundant of these, and they are relatively poor in lime. In this respect it is highly probable that the earliest rocks followed the same rule.

Many analyses of river waters have been made, some of them with reference to their geological relations. Waters emerging from areas of sedimentary rocks, or from basaltic regions, are quite unlike those which issue from granite and its congeners. The meteoric waters act differently upon different kinds of rock, and take up dissimilar loads of soluble substances. Waters from limestone or from certain ferromagnesian rocks are relatively rich in lime; those from dolomite contain a larger proportion of magnesia, and so on; the waters varying in composition as the rocks themselves vary. Each water at its point of origin has its own chemical characteristics, which are fixed by its lithologic

parentage. This fact, which is almost self evident, has been verified by numerous analyses, which, however, have received less attention than they deserve.

Persilicic rocks, as I have already stated, are now the most abundant plutonics and, in all probability, have been so from the beginning. There is no reason for supposing that in this respect any important change has occurred. Such rocks consist mainly of quartz and feldspar, with only minor accessories. Waters issuing from them are low in salinity but relatively rich in silica and alkalies, the proportion of silica being especially high and much in excess of lime. The silica often approaches 40 per cent of the total inorganic matter in solution, and in some tropical rivers exceeds 50 per cent. Such waters offer a most favorable environment for the growth of siliceous organisms, all of which are low forms of life, like the radiolarians, diatoms, and siliceous sponges. They, or their ancestors, were probably among the earliest organisms to develop inorganic skeletons, and were in greater abundance than the calcareous forms. Doubtless there were local areas, basaltic for example, in which the waters carried much lime in solution, and here the conditions would be reversed. In every case, however, the chemical character of the environment determined the chemical character of the plants or animals which appeared. I speak now, of course, only of those organisms which built skeletons to support their tissues, or shells to house them; the simplest, earliest forms of life were hardly more than aggregations of protoplasm. How that originated and how it became endowed with life, that is, the ability to move about, to assimilate food, and to reproduce its kind, are questions on which only speculation is possible. Such problems I must leave to others.

ZOOLOGY.—*Six new genera of unstalked crinoids belonging to the families Thalassometridae and Charitometridae.*[1] AUSTIN H. CLARK, National Museum.

A recent survey of the comatulid families Thalassometridae and Charitometridae has shown that the following six systematic units are worthy of recognition as genera:

[1] Published with the permission of the Secretary of the Smithsonian Institution.

Oceanometra, new genus

Genotype.—Thalassometra gigantea A. H. Clark, 1908.

Diagnosis.—A genus of Thalassometrinae (Thalassometridae) in which the dorsal surface of the ossicles of the division series and of the arm bases is covered with numerous prominent spines, which become stouter and more prominent on the proximal and distal borders; there are from 15 to 28 arms; the IIBr series are all, or mostly, 4(3+4); the ossicles of the division series and first four brachials are strongly and evenly rounded dorsally, appearing relatively narrow; one or both of the elements of each of the pairs of ossicles in the division series, and of the first brachial pair, bears a more or less prominent median keel; the distal borders of the brachials are evenly rounded and very spinous; the centrodorsal is large, more or less conical, the cirrus sockets arranged in ten columns, two in each radial area; the cirri are of variable length, composed of from 55 to 79 segments.

Range.—Moluccas to the Philippine and Hawaiian Islands.

Bathymetrical Range.—From 54 to 858 meters.

Included Species.—Oceanometra gigantea (A. H. Clark), *Oceanometra magna* (A. H. Clark), and *Oceanometra annandalei* (A. H. Clark).

Crossometra, new genus

Genotype.—Pachylometra investigatoris A. H. Clark, 1909.

Diagnosis.—A genus of Charitometridae in which the centrodorsal is more or less conical, with the cirrus sockets arranged in ten definite columns, two in each radial area; the cirri are XX–XL, 19–26, stout; there are from 26 to 33 arms 125 mm. to 150 mm. long; the IIBr series are 4(3+4); the IIIBr series are 2(1+2), or 2, internally developed in 1–2–2–1 order; IVBr series, if present, resemble the IIIBr series; the ossicles of the division series and lower brachials are in close apposition and sharply flattened against their neighbors, evenly rounded dorsally, with the dorsal surface usually more or less uneven; the brachials are evenly rounded dorsally; the oral pinnules are more slender than those succeeding, though not appreciably longer; the genital pinnules are only slightly expanded, the expansion involving a considerable number of segments and dying away gradually distally.

Range.—Kei Islands to the Malay Archipelago, the Philippine Islands, and southern Japan.

Bathymetrical Range.—From 54 to 403 meters.

Included Species.—Crossometra investigatoris (A. H. Clark), *Crossometra helius* (A. H. Clark), and *Crossometra septentrionalis* (A. H. Clark).

Perissometra, new genus

Genotype.—Antedon flexilis P. H. Carpenter, 1888.

Diagnosis.—A genus of Charitometridae in which the centrodorsal is more or less conical, with the cirrus sockets arranged in ten definite columns, two in each radial area; the cirri are usually large and stout,

XX–L (usually XX–XXX), 15–31; the arms are from 10 to 20 in number, from 75 mm. to 250 mm. (rarely less than 150 mm.) in length; the IIBr series, when present, are 4(3+4) or, less commonly, 2; the ossicles of the division series and the lower brachials are in close apposition and are sharply flattened against their neighbors; their dorsal surface is smooth or coarsely rugose, raised more or less sharply into a broad or narrow regular or irregular median tubercle, which may be longitudinally elongate; the division series usually make a relatively small angle with the dorsoventral axis, so that the lower part of the animal is relatively narrow; the brachials are evenly rounded dorsally, and the more proximal may bear a small rounded dorsal tubercle; the oral pinnules, though more slender than those succeeding, are not appreciably longer; the genital pinnules are only slightly expanded, the expansion always involving a number of segments and gradually tapering away distally.

Range.—Laccadive and Andaman Islands to Timor and the Kei Islands, and northward to the Philippines and southern Japan.

Bathymetrical Range.—From 73 to 1269 meters.

Included Species.—*Perissometra angusticalyx* (P. H. Carpenter), *Perissometra patula* (P. H. Carpenter), *Perissometra robusta* (P. H. Carpenter), *Perissometra selene* (A. H. Clark), *Perissometra gorgonia* (A. H. Clark), *Perissometra timorensis* (A. H. Clark), *Perissometra crassa* (A. H. Clark), *Perissometra lata* (A. H. Clark), *Perissometra flexilis* (P. H. Carpenter), *Perissometra invenusta* (A. H. Clark), and *Perissometra macilenta* (A. H. Clark).

Monachometra, new genus

Genotype.—*Pachylometra fragilis* A. H. Clark, 1912.

Diagnosis.—A genus of Charitometridae in which the centrodorsal is thick-discoidal or more or less columnar, with the cirrus sockets arranged in fifteen crowded columns; the cirri are XXX, 19; the arms are from 15 to 19 in number, 145 mm. long; all the division series are 2; the ossicles of the division series and the first two brachials are sharply flattened laterally, with the dorsal surface rising rather sharply into a blunt keel; the IBr_1 are produced inwardly, so that their inner apices nearly meet in the center of the calyx; the visceral mass rests on the ossicles of the IIBr series and first two brachials, and on the sharply flattened and almost horizontal inner face of the IBr_2 (axillary); the synarthrial articulations (between the elements of the division series and between the first two brachials) are extraordinarily brittle; the brachials have a faint and obscure median carination; the oral pinnules are of approximately the same length as those succeeding, though more slender; the genital pinnules are rather stout, but without a localized expansion.

Range.—Philippine Islands and the Moluccas.

Bathymetrical Range.—From 118 to 243 meters.

Included Species.—*Monachometra fragilis* (A. H. Clark).

Calyptometra, new genus

Genotype.—Charitometra lateralis A. H. Clark, 1908.

Diagnosis.—A genus of Charitometridae in which the proximal portion of the animal is robust, very broad, and well rounded, the profile of the division series and arm bases strongly convex; the ossicles of the division series and first four brachials which are in close apposition and sharply flattened against their neighbors, have the lateral borders strongly, the proximal and distal borders less strongly, everted, unmodified, finely tubercular, or crenulate, and possess each a narrow blunt median keel; the brachials are rounded dorsally, each usually with a prominent, though low, small rounded median tubercle, which beyond the middle of the arm gradually becomes obsolete; the 10 or 11 (only exceptionally more than 10) stout arms are 160 mm. to 180 mm. in length; the IIBr series, when present, are 2; the proximal pinnules are somewhat longer and more slender than their successors; the following pinnules are very stout in the basal half, thence tapering gradually to a slender tip, the expansion of the basal segments becoming less and less marked distally; the cirri are about XXX, 15–21 (usually 16–19), the component segments slightly constricted centrally with prominent ends.

Range.—Hawaiian Islands.

Bathymetrical Range.—From 574 to 812 meters.

Included Species.—Calyptometra lateralis (A. H. Clark).

Chondrometra, new genus

Genotype.—Chlorometra robusta A. H. Clark, 1911.

Diagnosis.—A genus of Charitometridae in which the 10 arms, from 75 mm. to 211 mm. in length, are stout at the base, becoming narrow and strongly compressed laterally in the outer portion; the mid-dorsal line of each brachial is elevated into a broad, high and blunt overlapping spine or tubercle; the ossicles of the division series and the first two brachials, which are in close apposition and are sharply flattened against their neighbors, have the central portion elevated in such a way that their dorsal surface is in the shape of a broadly V-shaped gable; the proximal pinnules are about as long as those succeeding, or at any rate no longer; the genital pinnules are only slightly expanded, the expansion involving a number of segments and tapering away evenly distally; the centrodorsal is large, sharply conical to more or less columnar, the cirrus sockets arranged in one irregular or two regular columns in each radial area; the cirri are XV–XXX, 18–28, stout, varying from short to very long.

Range.—Timor to the Meangis and Philippine Islands.

Bathymetrical Range.—From 520 to 1314 meters.

Included Species.—Chondrometra rugosa (A. H. Clark), *Chondrometra robusta* (A. H. Clark), and *Chondrometra aculeata* (P. H. Carpenter).

ETHNOLOGY.—*Some information from Spanish sources regarding the Siouan tribes of the East.* JOHN R. SWANTON, Bureau of American Ethnology.

The discovery of a group of tribes of the Siouan linguistic stock in the southeastern part of our country was in its day one of the great surprises in American Ethnology. The number and names of these, together with the relationships existing between them and the ethnological information regarding them furnished by early writers, were made the subject of a special study by Mr. James Mooney and the results appear in Bulletin 22, of the Bureau of American Ethnology, entitled *Siouan Tribes of the East.* Not much additional information bearing upon these peoples has since come to light and but very few alterations would be required in a new edition, so far as the Siouan tribes themselves are concerned. Nevertheless, as information regarding them is scanty it becomes proportionately more valuable, and for this reason I desire to call attention to one or two additional sources of information among Spanish writings.

The first of these, in a work long well known to students of American history but unfortunately overlooked by the ethnologist, is Peter Martyr's account of the province of Chicora, and the customs of its inhabitants, in his *De Orbe Novo.* The reason for this neglect is, no doubt, due in part to the dependence of investigators on Gomara's transcription of Peter Martyr's narrative, particularly because they were acquainted only with faulty translations of the latter, which contain grotesque and exaggerated statements tending to throw discredit upon the entire account, a discredit moreover which has ancient support from the historian Oviedo. The greater part of the information was derived by Peter Martyr from an Indian of Chicora, named by the Spaniards Francisco, who was carried to Spain and taught the Spanish language, but taken back as interpreter for Ayllon's colony which came to such an inglorious end in 1526. The original narrative is contained in the Seventh Decade of Peter Martyr's work, where it occupies all of the third book and parts of the second and fourth; and if one goes back to this, instead of trying to depend on later transcriptions and translations, he

will find little in it that can not be accounted for without impugning the honest intentions of the writer or his Indian informant. A close examination of the Ayllon narratives leads to the belief that Francisco of Chicora came from that part of the Atlantic coast of the Carolinas occupied by Siouan tribes, and in all probability from the neighborhood of the present Winyaw bay. Among several reasons for this belief may be cited the characteristic *r* sounds in the words, as in the name Chicora itself, which is so conspicuous among the Siouan dialects of this region. The material recorded by Peter Martyr contains some information regarding the economic lives of the people and their customs, some notes touching upon their myths, medical practice, etc., and particularly accounts of three of their ceremonies. Some trees also are mentioned and the native names borne by them. It should be noticed that most of this information concerns, not Chicora, but a neighboring province called Duhare or Duache.

A little further light is let in upon these people by documents in the Lowery collection, preserved in the Manuscripts Division of the Library of Congress, particularly by the narratives of two expeditions from St. Augustine under the command of Francisco Fernandes de Ecija, sent in search of an English colony reported to have been established somewhere to the north. The first of these was in the year 1605. The explorers passed along the coasts of Georgia and South Carolina until they came to the "barra de Cayegua," now Charleston harbor. Not far beyond was the bar of Joye, and twelve leagues beyond that a sandy point near which was the river Jordan. This latter (placed by the explorers in N. Lat. 33°11′) was, as we know well, the Santee, and the sandy point near by was evidently Cape Romain. It must be observed that the Cape San Roman of the Spaniards is not the Cape Romain of today, but probably Cape Fear, and we must not be surprised, therefore, to read immediately afterward that it was about 20 leagues from the River Jordan to Cape San Roman. We are informed that the chief of Joye ruled over all the land at the mouth of this river. The Indians told Ecija that it was large and that the interior people came down it in canoes

with cloaks (*huapiles*) and many other things, including copper and silver, to exchange for fish and salt. They stated also that pearls were found near the mountains in a place called Xoada, described as very populous. The explorers met a Christian Indian in this region named Alonso, who acted as interpreter; his father-in-law, whose name was Panto, was head chief of the town of Sati (sometimes spelled Hati). One of these Indians had been as far on the trail to Xoada as a town called Guatari. On the direct road thither they said the following places were encountered: Guatari, Coguan-Guandu, Guacoguayn-Hati, Guaca-Hati-Animache, Lasi, Guasar, Pasque, Cotique. From the mouth of the Santee to Xoada was thirty days, "as Indians travel."

Ecija entered the Jordan on his second expedition July 8, 1609, and found some small houses and fields sowed with corn. He heard of a Frenchman living in the town of Sati and sent the Indians to fetch him. The Frenchman then told Ecija that he had heard from one of the natives that there was a town called Daxe four days' travel beyond Sati, and one and a half days' travel beyond that another, called Guandape, on an island near which the English had established themselves. One of the Indians from whom the Frenchman had derived this information was from a town called Guamuyhurto, the other two from a town called Quixis, and one had acted as interpreter for the English. It would seem that the settlement referred to must have been the Roanoke colony and not that at Jamestown, then only two years old. Four leagues up the Jordan Ecija met three chiefs, Sati, Gaandul, and Guatari. Another town in the interior was known as Ypaguano, and still another, five days' journey from Alonso's village, was called Guaño. A river ten leagues from Cape San Roman [Cape Fear] was called by the natives the river Barachoare. Somewhere east of the Jordan and Santee was a province known as Amy.

With the exception of the interesting note regarding trade there is little direct ethnological information in all this. It does, however, yield some important facts regarding the tribes of the section. In the first place there can be little doubt that the Sati of Ecija are identical with the Santee of the English. In

native speech the *n* was probably nasalized, and the English chose to make a full *n* out of it while the Spaniards preferred to ignore it. It is equally evident that Guatari is the later Wateree, *gua* being a common Spanish equivalent of English *wa*. Joye is spelled in another place *Suye* and in still another *Xoye* or *Xoya*. As *x* was often employed by Spanish writers of this period to designate the *sh* sound, it is evident that the initial sound was either *sh* or *s;* and when we add to this the fact that the chief of Joye is represented as ruling over all of the land at the mouth of the Santee, the identity of Joye, Xuye, or Suye with the later Sewee becomes almost certain. If the name of one of the tribes mentioned by Ayllon and his chroniclers should be spelled Duache, as it appears in some places, instead of Duhare, it may be identical with Daxe, but no such tribe appears in later times. Xoada, the town near the mountains, is, as Mooney has shown, the tribe known to the English as Saraw, then living at the head of Broad river. If there has been a mistake in copying, Lasi may be intended for Issi, the old name of the Catawba. At any rate Guasar is undoubtedly Waxaw, while Pasque, although not found as a tribal name in the English period, is the Pasqui of Francisco of Chicora. On the authority of Lederer and some others Gregg and Mooney have expressed an opinion that in the latter part of the seventeenth century the Wateree were not on the river which now bears their name, but upon the Pedee or Yadkin.[1] Unless we suppose there were two divisions to the tribe, however, the statements just quoted indicate that this is a mistake, and that at least part of the Wateree were in their later well known historic seats almost at the beginning of the seventeenth century. In fact Ecija's testimony throughout is to the comparative permanence in location of the tribes in the area in question. The Sewee, Santee, Waxaw, and possibly Catawba are where the South Carolina settlers found them more than sixty years later. If there be an exception it is in the case of the Chicora, who may have been the Sugeree or the Shoccoree, found later by the Carolina colonists a considerable distance inland.

[1] Gregg, A., Hist. of the Old Cheraws, p. 7; Mooney, James, Bull. 22, Bur. Amer. Ethn., p. 81.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. Each of the scientific bureaus in Washington has a representative authorized to forward such material to this journal and abstracts of official publications should be transmitted through the representative of the bureau in which they originate. The abstracts should conform in length and general style to those appearing in this issue.

ELECTRICITY.—*The international system of electric and magnetic units.* J. H. DELLINGER. Bureau of Standards Scientific Paper No. 292 (Bull. Bur. Stds., **13**: 599–631). 1916.

A complete and distinct system of electric and magnetic units is in use, based on the international ohm and ampere, the centimeter, and the second. While these international units differ in their derivation from the electrostatic and electromagnetic units, they nevertheless represent very closely decimal multiples and submultiples of the theoretical electromagnetic units. The very slight differences are determined by absolute measurements made from time to time. One of the reasons why the international system is the most convenient and the most used electrical system is because it is centered around the phenomena of electric current. Electric current is more familiar and of vastly greater practical importance than electrostatic charges or magnetic poles, upon which the other two familiar systems are based. Another fortunate aspect of the international system is the convenience of its dimensional expressions. They are very simple, and directly suggest the ordinary relations of electrical theory and practice. Other systems, involving the definition of new units of certain quantities in such a way as to redistribute the factor 4π in the equations, have been proposed from time to time and some of these are now used to a limited extent. An attempt to redistribute the 4π's in an advantageous manner has been called a "rationalization" of the units. A careful study has been made to determine whether the advantages of these proposed systems are such as to justify the trouble and confusion incident to a general change of units. No such advantage has been found. A strong reason against a general change of units for the purpose of rationalization is the fact that a rationalized system is obtained merely by using the ampere-turn as the unit of magnetomotive force. D. J. M.

ELECTRICITY.—*A system of remote control for an electric testing laboratory.* P. G. AGNEW, W. H. STANNARD, and J. L. FEARING. Bureau of Standards Scientific Paper No. 291 (Bull. Bur. Stds., **13**: 581–597). 1916.

This paper describes a system of remote control which was developed primarily for use in testing electrical measuring instruments. Small multiple lever controllers, which may be operated in any one of several laboratory rooms, give complete control of the output of a group of motor-generator sets. For example, in testing a wattmeter, or an a.c. watthour meter on low power factor, the five levers of a controller give both a coarse and a fine adjustment of frequency, current, voltage, power factor, and an auxiliary d.c. voltage, respectively. The field rheostats are very long slide-wire resistances. They are tubular in form and are wound helically with the resistance wire. They are 32 mm. in outside diameter, and as much as 12 meters in length. When necessary they are cooled by circulating water through the tube. Special laminated brushes, which bear directly on the winding, are operated by small worm-geared motors which pull them along the tubes by means of cord and pulley. The phase relation of current to voltage is controlled by a motor-operated worm drive. A large, motor-operated, low voltage rheostat for currents up to 10,000 or 12,000 amperes is included in the system. P. G. A.

ELECTRICITY.—*A variable self and mutual inductor.* H. B. BROOKS and F. C. WEAVER. Bureau of Standards Scientific Paper No. 290 (Bull. Bur. Stds., **13**: 569–580). 1916.

The instrument consists of two pairs of fixed coils held in stationary hard rubber disks between which a third disk carrying two coils is arranged to be rotated. The form and the spacing of the coils were determined so as to secure the following advantages: (1) high ratio of inductance to resistance; (2) scale divisions of uniform length reading directly in units of inductance; (3) astatic arrangement of the coils, which reduces the liability of errors caused by the proximity of other instruments or of conductors carrying currents. Diagrams and data are given from which instruments of this type can be designed for given uses. Comparison is made of the new instrument and of some other older forms of variable inductor, including the Ayrton-Perry.

H. B. B.

GEOLOGY.—*Contributions to economic geology, 1915. Part I. Metal and non-metals except fuels.* F. L. RANSOME, et al. U. S. Geological Survey Bulletin 620. Pp. 361, with illustrations. 1916.

This bulletin is made up of short reports by a number of different authors as listed herewith:

A gold-platinum-palladium lode in southern Nevada. ADOLPH KNOPF.

Gold deposits near Quartzsite, Arizona. E. L. JONES, JR.

A reconnaissance in the Kofa Mountains, Arizona. E. L. JONES, JR.

A reconnaissance of the Cottonwood-American Fork mining region, Utah. B. S. BUTLER AND G. F. LOUGHLIN.

Notes on the fine gold of Snake River, Idaho. J. M. HILL.

Preliminary report on the economic geology of Gilpin County, Colorado. E. S. BASTIN AND J. M. HILL.

The Aztec gold mine, Baldy, New Mexico. W. T. LEE.

Iron Ore in Cass, Marion, Morris, and Cherokee counties, Texas. E. F. BURCHARD.

Iron-bearing deposits in Bossier, Caddo, and Webster parishes, Louisiana. E. F. BURCHARD.

Some cinnabar deposits in western Nevada. ADOLPH KNOPF.

Quicksilver deposits of the Mazatzal Range, Arizona. F. L. RANSOME.

Potash in certain copper and gold ores. B. S. BUTLER.

Recent alunite developments near Marysvale and Beaver, Utah. G. F. LOUGHLIN.

Nitrate deposits in southern Idaho and eastern Oregon. G. R. MANSFIELD.

A reconnaissance for phosphate in the Salt River Range, Wyoming. G. R. MANSFIELD.

Cassiterite in San Diego County, California. W. T. SCHALLER.

E. S. B.

ENGINEERING.—*Surface water supply of the United States, 1914. Part IV. St. Lawrence Basin.* NATHAN C. GROVER, et al. U. S. Geological Survey Water-Supply Paper 384. Pp. 128, with 2 illustrations. 1916.

This volume is one of a series of reports presenting results of measurements of flow made on streams in the St. Lawrence River Basin during the year ending September 30, 1914. It includes also a list of the stream gaging stations and publications relating to water resources in this Basin.

O. E. M.

REFERENCES

Under this heading it is proposed to include, by author, title, and citation, references to all scientific papers published in or emanating from Washington. It is requested that authors cooperate with the editors by submitting titles promptly, following the style used below. These references are not intended to replace the more extended abstracts published elsewhere in this JOURNAL.

ASTRONOMY

ABBOT, C. G., FOWLE, F. E., ALDRICH, L. B. *Confirmatory experiments on the value of the solar constant of radiation.* Proc. Nat. Acad. Sci., **1**: 331–333. 1915.

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